



THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Daniel J. Woodruff, et al.

Application No.: 10/084,962

Confirmation No.: 2206

Filed: February 27, 2002

Title: ELECTROPLATING APPARATUS WITH
SEGMENTED ANODE ARRAY

Art Unit: 742

Examiner: Donald R. Valentine

Docket No.: 114183-7 (P98-0040US2)

**DECLARATION UNDER 37 C.F.R. § 1.131
OF DANIEL J. WOODRUFF AND KYLE M. HANSON**

We, Daniel J. Woodruff and Kyle M. Hanson, hereby declare and say that:

We are the inventors of the subject matter disclosed and claimed in the above-identified application, having made the invention described therein in the United States. We conceived and reduced to practice the subject matter of the claims in this application prior to April 21, 1998, the earliest filing date claimed by U.S. Patent No. 6,261,433 ("the '433 patent").

2. To demonstrate such prior conception and reduction to practice, we attach hereto as Exhibit A our Invention Disclosure for the concentric anode array reactor and, as Exhibit B our Invention Record describing the anode

Application No. 10/084,962
Declaration Under 37 C.F.R. § 1.131
March 23, 2005

configuration, both forming the basis for the drawings contained in the above-identified application. Exhibit A, naming ourselves as inventors thereof, was prepared and signed by us well prior to April 21, 1998 and lists dates of conception and written description also prior to April 21, 1998. In addition, Exhibit A was witnessed and understood by two colleagues at Semitool, Inc., also prior to April 21, 1998.

3. Exhibit B which we both signed was also prepared prior to April 21, 1998 and witnessed before that same date. Together, Exhibits A and B were used in the preparation of the drawings contained in the present application, thus establishing conception of the method and apparatus disclosed in the above-identified application prior to April 21, 1998.

4. The segmented anode described in the present application is shown in Semitool engineering drawings, Exhibits C, D, E, F, G, H and I, just as described in the present application. The drawings of Exhibits C-I were each made prior to April 21, 1998 and were used to construct the segmented anode at the facility of Semitool, Inc. in Kalispell, Montana. That segmented anode was built, installed in a plating reactor as described in the present application and shown in Exhibits A and B, and that apparatus was successfully tested prior to April 21, 1998.

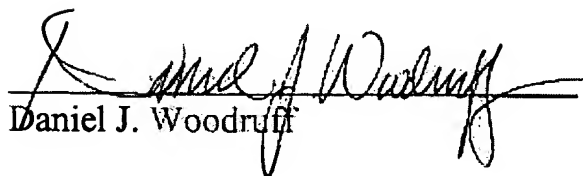
5. The dates contained on each of the exhibits have been removed, but all are prior to April 21, 1998, and thus corroborate conception and reduction to practice of the subject matter disclosed and claimed in the present application.

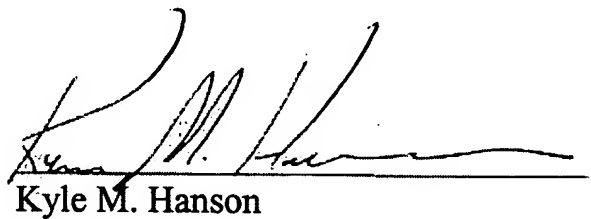
Application No. 10/084,962
Declaration Under 37 C.F.R. § 13
March 23, 2005

6. hereby declare under the penalty of perjury under the laws of the United States of America that the foregoing is true and correct to the best of my knowledge and belief.

7. Further declarants sayeth not.

Executed this 23rd day of March, 2005 in Kalispell, Montana.


Daniel J. Woodruff


Kyle M. Hanson

INVENTION DISCLOSURE

SEMITOOL, INC.

D 0006

- Note:
1. Use Ink or Type Only
 2. Do not erase errors. Line through any errors, initial and date.
 3. Describe invention with drawings, sketches, etc. and a written explanation. Drawings may be below or attached. If attached, the inventor(s) and witnesses must sign and date each sheet.
 4. Describe the advantages of this invention compared to the current approach, if any.
 5. Inventor(s) and two (2) witnesses must sign and date each sheet.
 6. Send original signed documents to the Intellectual Property Department. Retain a personal copy.

Inventor(s) Name and Social Security Number

Daniel J. Woodruff
Kyle M. Hanson

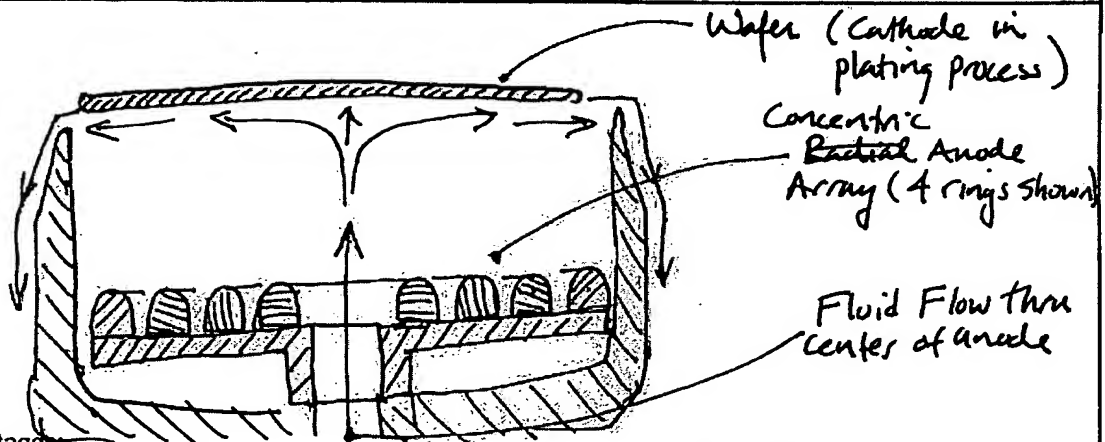
Title of Invention:

TOOL: Plating

Concentric Anode Array with Centered Fluid Flow

Invention:

Sketch



Explanation and Advantages:

Plating fluid is pumped through the center of the anode array and impinges on the wafer surface. The plating rate on the wafer surface will vary radially ~~across the~~ due to the effect of the impinging fluid on the hydrodynamic boundary layer. This radial effect can be compensated for ~~the~~ by operating the anode rings at different electrical potentials.
(continued on attached sheet)

Signature(s) of Inventor(s):

Date:

Date of Conception:

Date of First Sketch/Drawing:

[Signatures of Daniel J. Woodruff and Kyle M. Hanson]

Witnessed and Understood By:

Date:

Date of Written Description:

Working Model Prepared?

[Signatures of two witnesses]

Yes/No

Date:

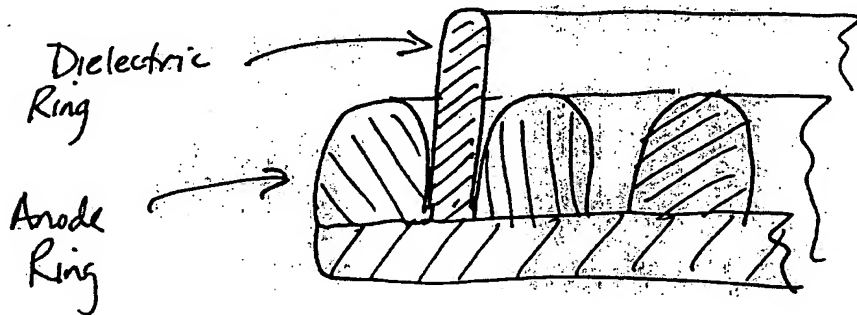
Blumberg No. 5118

EXHIBIT

A

Explanation and Advantages (Cont.)

In addition to affecting plating uniformity by using different anode potentials it would also be possible to affect uniformity with dielectric (insulating) material placed between the anode ring (see sketch



The geometry of the dielectric material could be modified to provide the desired effect on plating. Tall geometries would tend to limit interaction of adjacent anodes (and perhaps collimate current flow to the wafer) while shorter or perforated geometries would tend to increase anode interaction. Similar effects may also be possible by positioning the anode rings at varying distances from the wafer surface. The advantages to this design are:

- 1) No diffuser is required between the anode and wafer. Fluid flow rate and current distribution can be controlled independent of one another in the proposed design, but can't in the existing system which uses a diffuser constructed of dielectric material. Having these variable independently controllable makes it easier to optimize the plating process.
- 2) Air bubbles introduced into the plating chamber by the incoming fluid flow are simply flushed passed the wafer surface and won't interfere with the plating process. With the existing system utilizing a diffuser these bubbles can attach to the diffuser surface and adversely impact diffuser performance.
- 3) Fluid flow through the center of the anode ensures the wafer surface will be wetted from the center out. This will prevent air being trapped at the center of the wafer when it first contacts the fluid surface.

Daniel J. Warduff
Karl H. Lee

INVENTION DISCLOSURE

SEMITOOL, INC.

D-0005
B-50

- Note:
1. Use Ink or Type Only
 2. Do not erase errors. Line through any errors, initial and date.
 3. Describe invention with drawings, sketches, etc. and a written explanation. Drawings may be below or attached. If attached, the inventor(s) and witnesses must sign and date each sheet.
 4. Describe the advantages of this invention compared to the current approach, if any.
 5. Inventor(s) and two (2) witnesses must sign and date each sheet.
 6. Send original signed documents to the Intellectual Property Department. Retain a personal copy.

Inventor(s) Name

KYLE M. HANSON

HENRY . STEVENS

CHRIS K. HAUGAN

DANIEL J. WOODRUFF

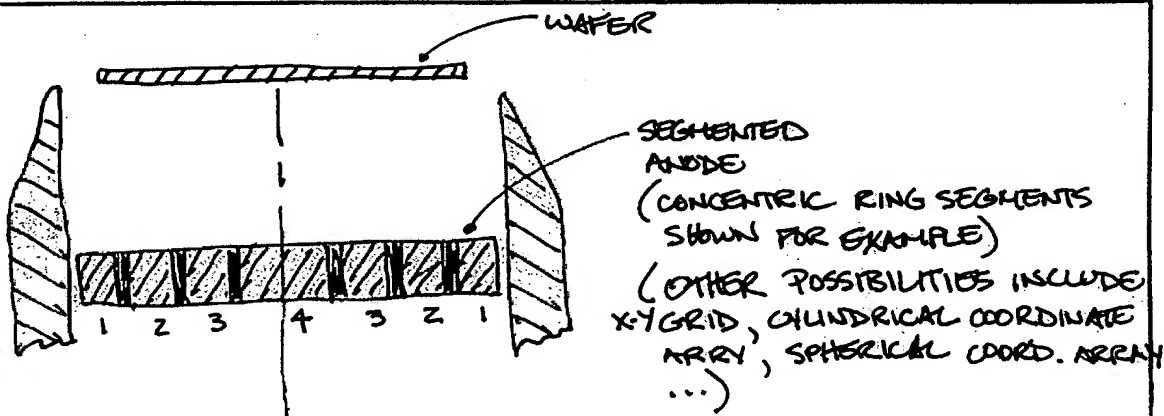
Tool or Process: ELECTROCHEMICAL DEPOSITION

Title of Invention:

ANODE CONFIGURATION DYNAMIC CONTROL

Invention:

Sketch



Explanation and Advantages:

Then the use of a segmented anode structure and independent electrical control on each of these segments (definition of voltage or current flow), the capability to dynamically modify the anode configuration is enabled. This allows for optimization of the anode and therefore reactor current flow in order to compensate for the transient

Signature(s) of Inventor(s):

Date:

Date of Conception:

Date of First Sketch/Drawing:

Chris Haugan

Henry Stevens

Daniel J. Woodruff

Witnessed and Understood By:

Date:

Date of Written Description:

Working Model Prepared?

Kyle Hanson

Chris Haugan

Henry Stevens

Daniel J. Woodruff

Yes

No

Date:

Blumberg No. 5118

EXHIBIT

B

Explanation & Advantages (cont)

effects from the plated film growth on the wafer. As the film grows on the wafer the current distribution on the wafer will change due to the difference in the films electrical conductivity.

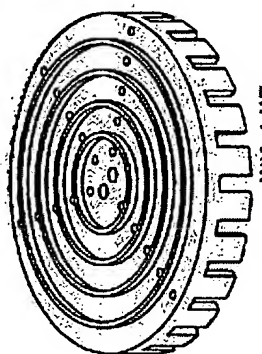
This capability to dynamically alter the anode configuration as the process progresses is becomes more important in the case of high resistance seed layers. In this case, the transient change in the film characteristics is made larger in magnitude as a layer of high electrical conductivity copper, for example, is deposited on a much lower conductivity layer.

That is, the plating is more sensitive to the local current density at the surface. For the purpose of local current density, we use the potential applied to each anode segment individually.

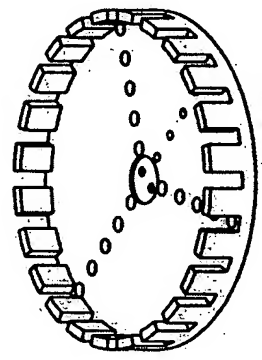
[Signature]

Chris Hargan
David W. Wadsworth
Henry Stevens
Kurt Hargan
Loren

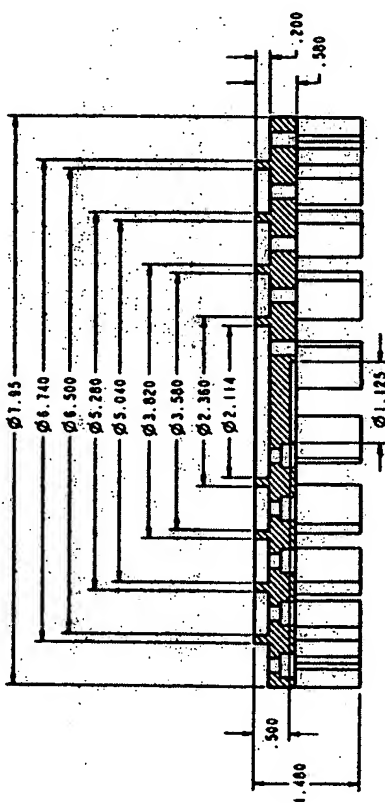
REV	DATE	DESCRIPTION	BY	CHKD
1	10/1/68	REVISION		



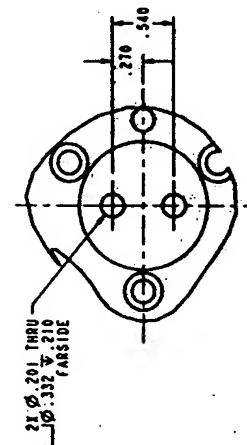
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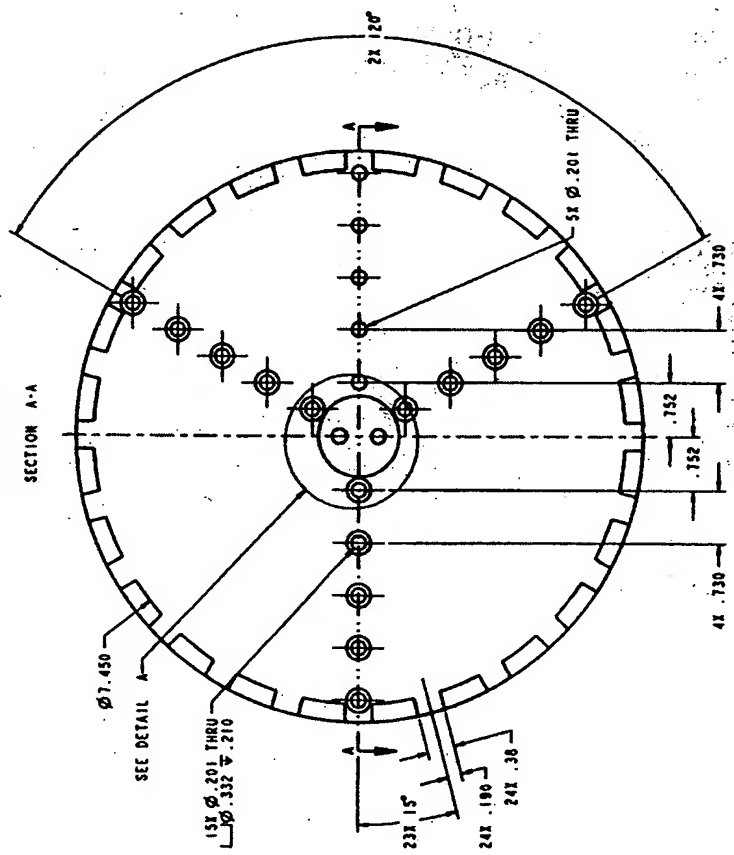
SCALE 4.3125



SECTION A-A



DETAIL A
SCALE 1:000



REV	DATE	DESCRIPTION	BY	CHKD
1	10/1/68	REVISION		

SEMITOOL
MOUNT ANODE
VARIABLE ARRAY

REV	DATE	DESCRIPTION	BY	CHKD
1	10/1/68	REVISION		

SEMITOOL PROPRIETARY

Blumberg No. 5118

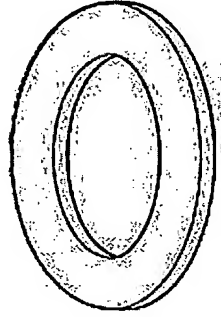
EXHIBIT

C

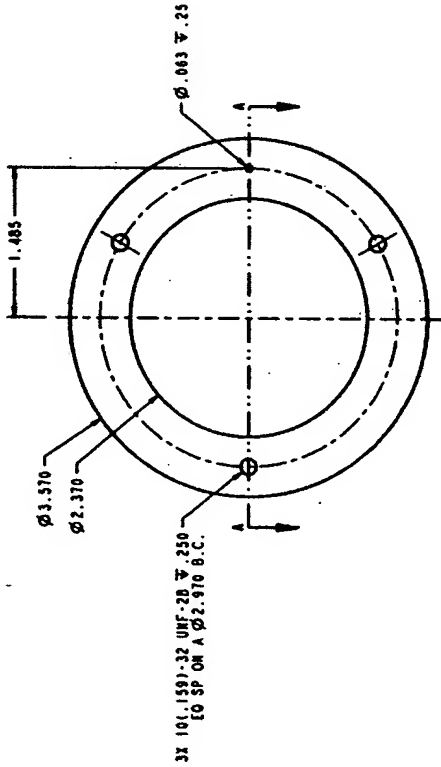
REV	DATE	DESCRIPTION	BY	CHKD
A		REVISION		



SECTION A-A



SCALE: 0.750



NOTES:

- CHEMICAL COMPOSITION PERCENT ±
 - COPPER 99.80 MIN.
 - PHOSPHOROUS 0.045 TO .06
 - IRON 0.003 MAX.
 - SULFUR 0.003 MAX.
 - LEAD 0.002 MAX.
 - ANTIMONY 0.002 MAX.
 - NICKEL 0.001 MAX.
 - ARSENIC 0.001 MAX.
 - TOTAL OTHER 0.01 MAX.
- SILVER COUNTED AS COPPER
- MATERIAL CERTIFICATION TO BE PROVIDED WITH RAW MATERIAL.

COPPER, PHOSPHOROUS CONTENT .045-.061	
DATE	11/02/25
SEMITOOL TM BY BALLISPELL, INC.	
ANODE, RING, 2.97 DIA	
ITEM NO.	AT00235

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

REV	DATE	DESCRIPTION	BY	CHKD
A		REVISION		

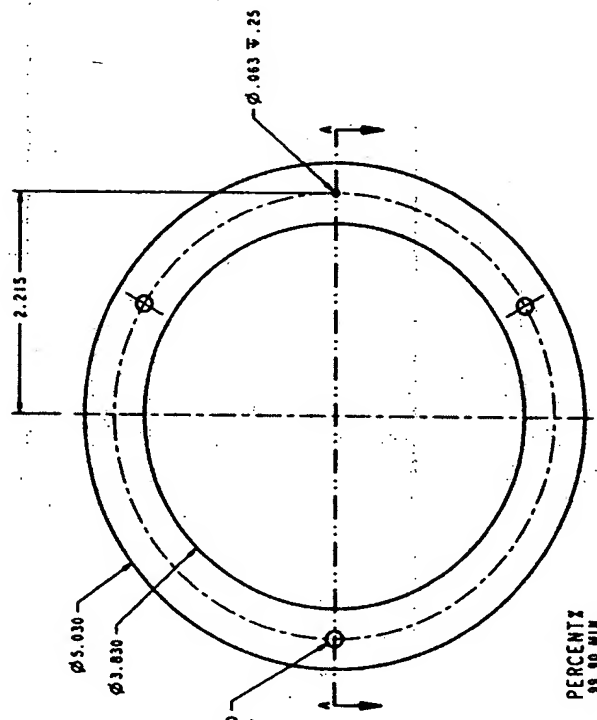
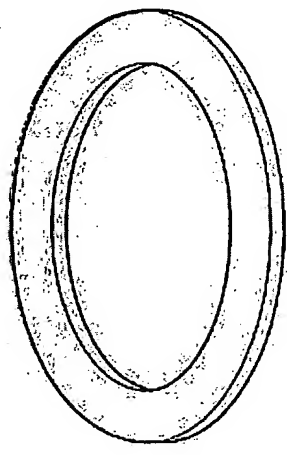
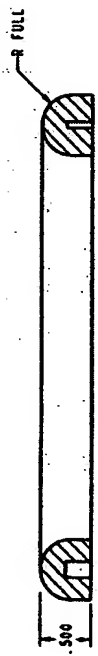
SEMITOOL PROPRIETARY

Exhibit No. 0100

EXHIBIT

D

REV	DATE	DESCRIPTION	BY	CHKD
1		REVISION		



NOTES:
1. CHEMICAL COMPOSITION

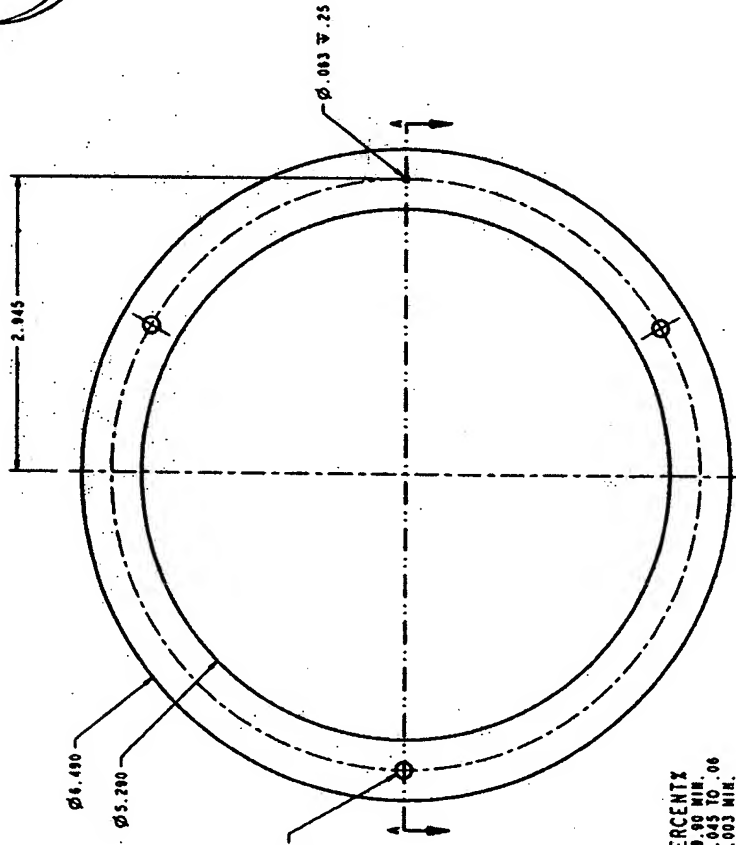
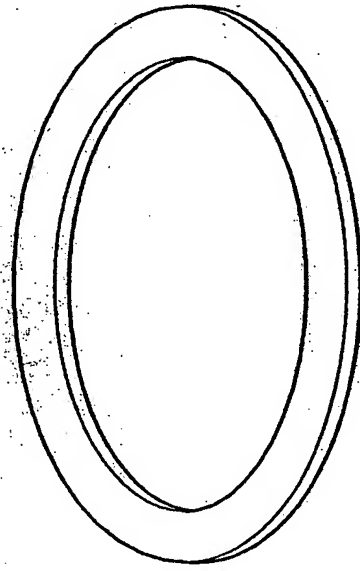
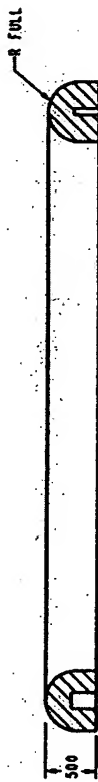
	PERCENT
COPPER	99.90 MIN
PHOSPHOROUS	0.045 TO .06
IRON	0.003 MAX
SULFUR	0.003 MAX
LEAD	0.002 MAX
ANTIMONY	0.002 MAX
NICKEL	0.002 MAX
ARSENIC	0.001 MAX
TOTAL OTHER	0.01 MAX

2. MATERIAL CERTIFICATION TO BE PROVIDED WITH RAW MATERIAL.

SEMITOOL TM HALLIPPELL, NY	
ANODE, RING, 4.43 DIA	
DATE: 8.11.51	ATG0236

Blumberg No. 5110
EXHIBIT

REV	DATE	DESCRIPTION	BY	CHKD
1		REVISION		



3X 10(.1591-.32 UNF-28 ± .250
EQ SP ON A Ø 5.890 B.C.

NOTES:

- CHEMICAL COMPOSITION

	PERCENT
COPPER	89.99 MIN.
PHOSPHOROUS	0.045 TO .06
IRON	0.003 MAX.
SULFUR	0.003 MAX.
LEAD	0.003 MAX.
ANTIMONY	0.003 MAX.
NICKEL	0.003 MAX.
ARSENIC	0.001 MAX.
TOTAL OTHER	0.01 MAX.

*SILVER COATED AS COPPER

2. MATERIAL CERTIFICATION TO BE PROVIDED WITH MATERIAL.

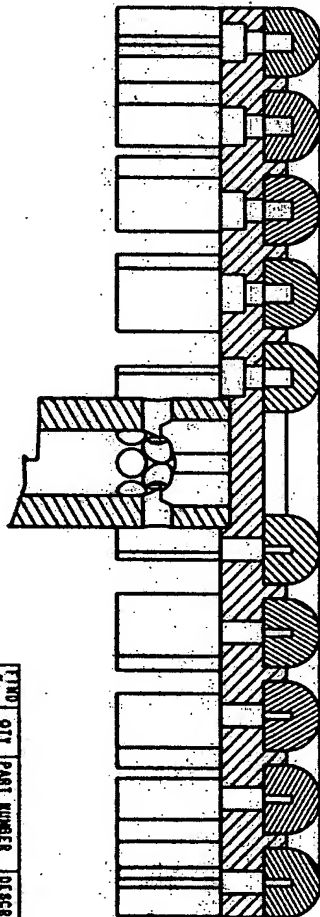
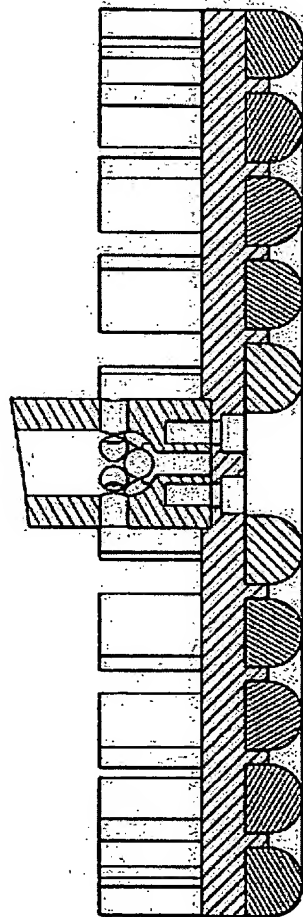
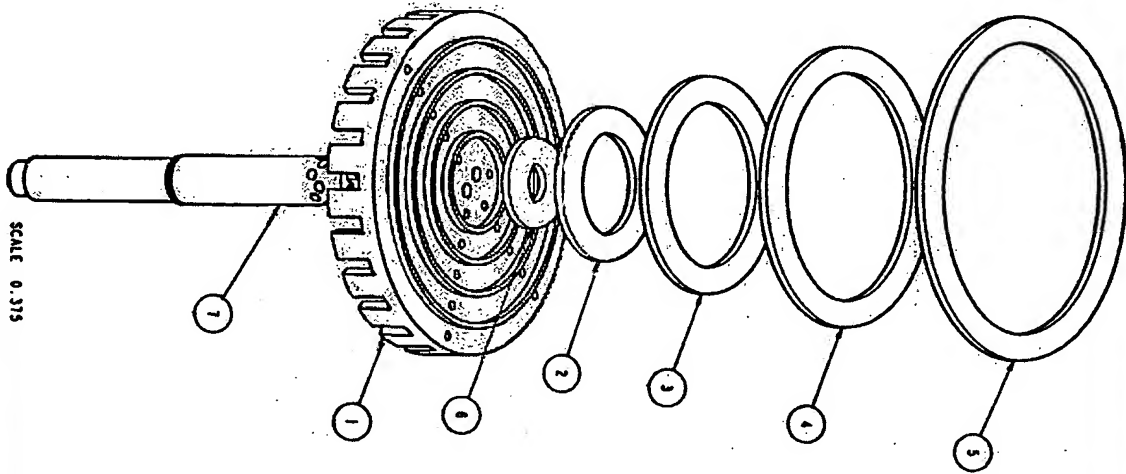
COPPER, PHOSPHOROUS CONTENT, 89.99-90.01	
ITEM NO.	AT00237
QUANTITY	1
DATE	0.1.1.1
SEMITOOL TM HALLS FALL, VT	
ANODE, RING, 5.89 DIA	



DATE	REV	BY	CHKD	APPD

SEMITOOL PROPRIETARY





ITEM NO.	QTY	PART NUMBER	DESCRIPTION
1	1	ATG0234	ANODE, RING, 2.97 DIA.
2	1	ATG0235	ANODE, RING, 4.43 DIA.
3	1	ATG0236	ANODE, RING, 5.89 DIA.
4	1	ATG0237	ANODE, RING, 7.35 DIA.
5	1	ATG0238	ANODE, RING, 8.81 DIA.
6	1	ATG0334	ANODE, RING, 2.97 DIA.
7	1	ATG0337	POST, ANODE, CONSUMABLE, NOT PLATED

SEMITOOL, INC.
ANODE ASSEMBLY
VARIABLE ARRAY

REV	DATE	BY	CHKD	APP'D	DESCRIPTION
1	10/1/83	10/1/83	10/1/83	10/1/83	ATG0233

REV	DATE	BY	CHKD	APP'D	DESCRIPTION
1	10/1/83	10/1/83	10/1/83	10/1/83	ATG0233

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